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(54) Cathode ray tube with implosion protection and method for manufacturing it.

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(73) Proprietor: RCA CORPORATION
30 Rockefeller Plaza
New York, NY 10020 (US)

(72) Inventor: Deal, Samuel Broughton
221, Bluff View Drive
Lancaster Pennsylvania 17601 (US)
Inventor: Bartch, Donald Walter
13th St. & Ironville Pike Rural Delivery 3
Columbia Lancaster Pennsylvania 17512 (US)

(74) Representative: Smith, Thomas Ian Macdonald et al,
50 Curzon Street
London W1Y 8EU (GB)

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Cathode ray tube with implosion protection and method for manufacturing it

This invention relates to providing cathode-ray tubes with implosion protection.

Cathode-ray tubes comprising evacuated glass bulbs are mass-produced articles of commerce. They usually include a glass faceplate panel hermetically sealed to the wide end of a glass funnel. A luminescent screen is carried on the inner surface of the panel, and one or more electron guns are housed in a neck attached to the narrow end of the funnel. Some adverse effects of implosion of the bulb can be reduced or eliminated by providing an implosion-protection system around the panel.

In one such system, as described for instance in US—A—3,162,933, 3,206,056 and 3,220,593, a rigid coating of a plastic-impregnated fiber or fabric encircles and adheres to the panel. An encircling steel band on or adjacent to the plastic impregnated coating may or may not also be provided. The plastic adhesive is usually a self-curing epoxy or polyester material. In other systems such as disclosed in GB—A—1168350, 1191506 and 1040381, an implosion-resisting band such as of metal or glass fiber is placed round the cathode-ray tube and adhered to it by an adhesive for which various materials, including polyurethane, have been suggested. It has also been suggested, for instance in GB—A—1040381 already mentioned and in FR—A—1349345, to apply a sheath or lining of foamed polyurethane (or other material) to provide implosion protection with the possibility, according to FR—A—1349346 that the foamed sheath may be self-adherent to the cathode-ray tube or may be stuck to it, for instance by polyurethane adhesive.

These prior implosion protection systems tend to be relatively difficult and expensive to construct and are not well adapted to mass production. While these prior systems may provide the required degree of safety to the viewer of the tube, it is desirable to provide an implosion-protection system which is easier and cheaper to manufacture without sacrificing the degree of safety that is required for the viewer.

It has also been previously proposed, in US—A—3184327, to provide implosion protection by applying a cellulose film coating across the external surface of the faceplate window of a cathode-ray tube, this having the disadvantage however of requiring the cellulose coating to have good optical clarity, transparency and freedom from wrinkles. According to the present invention it has been surprisingly found that good implosion protection can be achieved by applying an adherent elastomeric film coating consisting essentially of polyurethane as a continuous band which can be as little as 0.075 millimetre thick around portions of the cathode-ray tube envelope including its side wall but excluding the external surface of its faceplate window. The preferred film thickness is between 0.075 and 0.125 millimeter. The invention also includes a method of providing implosion protection by preheating the cathode-ray tube to between about 20°C to 90°C, applying a water based emulsion of polyurethane to the relevant surfaces of the cathode-ray tube envelope by brushing, flowing or spraying, and thereafter heating the coated tube to between about 20°C and 120°C for about 30—5 minutes to leave the required elastomeric polyurethane film. By employing this method, cheaper materials and simpler processes which are better adapted to mass production may be used in fabricating the tubes. Even with the addition of tensioned metal bands, especially for larger tube sizes, adequate implosion protection can thereby be provided with lighter weight and at lower costs.

In the drawings:

FIGURES 1 to 5 are elevational views of five different embodiments of the invention.

FIGURE 6 is a graph showing the results of a series of tests for determining tensile strength of polyurethane coatings versus thickness of the coating.

The cathode-ray tube illustrated in Figure 1 includes an evacuated envelope designated generally by the numeral 21. The envelope 21 includes a glass neck 23 integral with a glass funnel 25, and a glass faceplate panel comprising a viewing window 27 having a peripheral sidewall 29. The rim of the sidewall 29 is sealed to the wide end of the funnel 25 by a seal 31, such as devitrified glass. The neck 23 is closed and sealed by a stem 35 having stem leads 37 extending therethrough. An anode button (terminal) 43 is sealed through the funnel wall. A luminescent screen (not shown) resides on the inside surface of the viewing window 27. The luminescent screen, when suitably scanned by an electron beam from a gun 33 housed in the neck 23, is capable of producing a luminescent image which may be viewed through the viewing window 27.

The interior of the envelope is evacuated to a high level of vacuum (low pressure) of the order of 10^{-5} mm Hg. Considering a 19V 90° rectangular color television picture tube by way of example, atmospheric pressure pressing against the external surface of the viewing window exerts forces totaling about 1800 kilograms. Circumferential tensile stresses as high as 70 kg/cm^2 are present in the sidewall 29 and the adjacent portions of the funnel. Should the viewing window fracture, atmospheric pressure would ordinarily drive window fragments inward against the funnel portion 25, from which they would then bounce outward. An implosion-protection system does not prevent such implosion but, instead, reduces the chance of injury to viewers near the tube face. Particu-

larly, an implosion-protection system reduces the amount of glass fragments thrown and reduces the distances that they are thrown.

In accordance with one embodiment of the invention, a continuous peripheral film coating 39 of polyurethane about 0.125 mm (5 mils) thick is adhered to external surface portions of the sidewall 29 and the funnel 25 on each side of the seal 31. For the example considered, the film coating 39 is about 12.5 cm wide, extending from the seal about 5 cm toward the window 27 and 7.5 cm toward the neck 23. Should the window 27 fracture, the film coating 39 adherent to external envelope surfaces maintains the adjacent glass in place while permitting gas to rush into the tube, reducing the pressure differential on opposite sides of the window 27, thereby reducing the forces which drive glass fragments into flight. To determine the adequacy of implosion protection of tubes described herein, implosion tests specified in publication UL 1418 by Underwriters Laboratories, Inc., Chicago, Ill., U.S.A., were used.

The film coating 39 in the embodiment of Figure 1 is fabricated on the tube after the envelope 21 has been completely evacuated of gases and sealed, and the electrodes of the gun 33 have been electrically processed. In a preferred method of fabrication of the film, a quantity of an emulsion of polyurethane in a water base is diluted with water to the desired viscosity. One suitable polyurethane emulsion is RS 5302 marketed by PPG Industries, Coatings and Resin Products Division, Springdale, Pa., U.S.A. The mixture is then brushed, flowed or preferably sprayed on the desired areas using a stencil to define such areas. When spraying on the emulsion, it has been found to be convenient to monitor the emulsion-coating thickness by including a water-soluble dye, such as Hidrocal Alpha Blue, marketed by Hercules, Inc., Glen Falls, N.Y., U.S.A., in the emulsion. The emulsion is applied to a depth of color corresponding to the desired thickness. In a preferred procedure, based on the spectral reflectivity of the dyed coating being a function of coating thickness, fluorescent light is used and reflectance measurements are taken with a blue and with a red filter. The thicker the coating, the higher the blue-to-red ratio of these reflectances. After the emulsion has been applied, the emulsion coating is dried and the solids therein coalesced to a substantially uniform film. This 'curing' of the film may be done by heating the tube in an oven in an ambient of air at about 20° to 120°C for about 30 to 5 minutes, preferably about 90°C for about 10 minutes, and then cooling the tube. Alternatively, or in addition, the tube may be pre-heated in an oven to about 20° to 90°C, preferably about 50°C, prior to applying the emulsion coating. After the coating has been cured, the film is at least 0.075 mm (3 mils) thick and preferably about 0.125 mm (5 mils) thick. Greater thicknesses are not detrimental to implosion protection, although too thick a film results in excessive material costs. It is surprising that, without reinforcement by fabric or other fibrous material in the films, sufficient protection can be realized with such thin films and with the use of so little polymeric material.

The tubes of Figures 2 and 3 are identical in structure to that of Figure 1 except for the extent of the film coating 39. Hence, similar reference numerals are used for similar structures. In Figure 2, a film coating 39a extends back on the funnel 25 almost to the neck 23. An open area 41 is left around the anode button 43 to permit the connection of a high-voltage lead thereto. In Figure 3, a film coating 39c is shortened so that it lies only on the panel sidewall and does not extend over the seal 31 or the window 27. Even though the coating 39c is narrow, it nevertheless provides implosion protection that is adequate for many tubes, particularly when used in combination with one or more tensioned steel bands.

The tubes of Figures 4 and 5 are identical in structure to that of Figure 1 except that one or more continuous steel bands are tensioned to about 450 to 675 kilograms around the sidewalls 29 of the panel; plastic coated bands are preferred. Hence, similar reference numerals are used for similar structures. In Figure 4, a band 45 and a metal clip 47 are on top of a film coating 39d. In Figure 5, a band 49 and a metal clip 51 are under the film coating 39c. Two tensioned bands, one on top of the other, may also be used over or under the film coating. These combinations of film coating and tension band are used on larger (above 19V) cathode-ray tubes. In one test on a 25V 100° tube, two bands each tensioned to about 450 to 625 kilograms over a film coating about 0.10 mm (4 mil) thick, as shown in Figure 4, provided adequate implosion protection, where one or the other alone was not adequate. In a further variation, the film coating 39d of Figure 4 was made discontinuous by leaving eight gaps of about 50 mm round the periphery of the tube: here also, the film coating and tensioned-band combination provided adequate implosion protection.

Tensile tests were conducted on polyurethane films that were made with aqueous emulsions applied by draw-down blade or spray to mold-released glass plates. After being subjected to an appropriate cure schedule, and/or environmental test cycle, 1 × 2 inch (about 25 × 50 mm) sections of film coating were removed and pull tested. The applicable ASTM test was used to determine tensile strength at the breakpoint for specimens of 1 inch (about 25 mm) width. Results are plotted in the graph shown in Figure 6. It is concluded from this data, and confirmed by implosion experience with tubes, that the film coating should be at least 0.075 mm (3 mils) thick. During tensile tests, it was observed that the cured polyurethane films elongated about 400 to 500% in

the direction of pull.

Adhesive strengths of polyurethane films to glass were determined by applying emulsions by draw-down blade or by spray to nonmold-released glass plates. After being outlined with a cutting tool, one end of a 2 inch (about 50 mm) strip was reinforced and attached to a spring scale and pulled off the plate at a 90° angle according to the ASTM method. This pull test was repeated on external funnel and sidewall surfaces of cathode-ray tubes. Pull test results averaged about 4.5 kilograms on funnel surfaces and about 6.4 kilograms on sidewall surfaces. These results are much higher than the minimum of about 1.4 kilograms considered necessary for adequate implosion protection.

For forming the protective films it is preferred to employ polyurethane latexes, that is, aqueous emulsions or sols in which each colloidal particle contains a number of macromolecules of polyurethane. The colloidal particles are about 0.05 to 1.0 micron, preferably less than 0.3 micron, in average size. The latexes are ones from which the water base can be removed and the macromolecules coalesced into an adherent film coating on a glass surface. Other aqueous emulsions of polymeric materials have been tried, but only polyurethane has been found to develop sufficient tensile strength and adherence in coalesced film coatings. The colloidal particles of the latexes should have a relatively low minimum film-forming temperature, or MFT preferably more than 20°C below the temperatures at which curing is carried out. The latexes may include other constituents, such as a coloring dye, a defoaming agent and/or a stabilizing agent.

It is the practice to apply an electrically-insulating polymeric coating around the anode button of a cathode-ray tube and also an electrically-conducting coating, usually of graphite and a binder, on the outer surface of the funnel of the tube. From several tests, it was found that these coatings can be under, but preferably should be over, the polyurethane film coatings disclosed herein. When these other coatings are over the polyurethane film coatings, the latter has been found to have a negligible effect on the performance of the cathode-ray tube.

Reference has been made in the foregoing to 19V and 25V tubes. It is to be understood that these are tubes having viewing areas with nominal diagonal dimensions of 19 inches (about 48 cm) and 25 inches (about 63.5 cm) respectively.

Claims

1. A cathode-ray tube comprising an evacuated envelope (21) including a glass faceplate panel (27, 29) with a viewing window (27) and an integral sidewall (29) around said window, and an adjoining glass funnel (25) sealed to said sidewall, characterized by an elastomeric film coating (39) consisting essentially of polyurethane being a continuous band at least about 0.075 millimeter thick around portions of said envelope including said sidewall and adhering to external surfaces thereof, the external surface of said window being free of said coating.

2. A cathode-ray tube as claimed in claim 1, characterized in that the thickness of said coating is between about 0.075 millimeter and 0.125 millimeter.

3. A method for manufacturing a cathode-ray tube according to claim 1, the method comprising applying a coating composition to an external glass surface of said envelope excluding said window and then heating the coated tube to a temperature sufficient to effect adherence of said coating to said surface, characterized by preheating said tube to between about 20°C and 90°C, applying said coating composition by brushing, flowing or spraying onto said envelope surface a water-based emulsion of polyurethane, and heating said coated tube to between about 20°C and 120°C for about 30 to 5 minutes.

Patentansprüche

1. Kathodenstrahlröhre mit einem evakuierten Kolben (21), der eine Frontglaswanne (27, 29) mit einem Bildfenster (27) und einer dieses umgebenden integralen Seitenwand (29), sowie einen angrenzenden Glastrichter (25), der mit der Seitenwand dicht verbunden ist, aufweist, gekennzeichnet durch eine elastomere Überzugschicht (39), die im wesentlichen aus Polyurethan besteht, ein mindestens etwa 0,075 mm dickes kontinuierliches Band um Teile des Kolbens einschließlish der Seitenwand ist und an Außenflächen hiervon haftet, wobei die Außenfläche des Bildfensters frei von der Überzugschicht ist.

2. Kathodenstrahlröhre nach Anspruch 1, dadurch gekennzeichnet, daß die Dicke der Überzugschicht zwischen etwa 0,075 mm und 0,125 mm liegt.

3. Verfahren zum Herstellen einer Kathodenstrahlröhre nach Anspruch 1, bei welchem eine Beschichtungszusammensetzung auf eine äußere Glasoberfläche des Kolbens ausschließlich des Fensters aufgebracht und die überzogene Röhre dann auf eine Temperatur erhitzt wird, die ausreicht, um ein Haften des Überzuges an der Oberfläche zu bewirken, dadurch gekennzeichnet, daß die Röhre auf zwischen etwa 20°C und 90°C vorgewärmt wird, daß die Überzugszusammensetzung durch Aufpinseln, Aufgießen oder Aufsprühen einer Polyurethanemulsion auf Wasserbasis auf die Kolbenoberfläche aufgebracht wird, und daß die überzogene Röhre für etwa 30 bis 5 Minuten auf zwischen etwa 20°C und 120°C erhitzt wird.

Revendications

1. Tube à rayons cathodiques comprenant une enveloppe mise sous vide (21) comportant un panneau de plaque frontale en verre (27, 29) avec une fenêtre d'observation (27) et une paroi latérale (29) autour de ladite fenêtre dont elle fait partie intégrante, et une partie adjacente tronconique en verre, en forme d'entonnoir (25) scellée à la paroi latérale, caractérisé en ce qu'il comporte un revêtement constitué d'une pellicule d'élastomère (39) composée essentiellement de polyuréthane sous la forme d'une bande continue ayant une épaisseur d'environ 0,075 mm, au moins, disposée autour des portions de ladite enveloppe comportant ladite paroi latérale et adhérant aux surfaces externes de celle-ci, la surface externe de ladite fenêtre étant exempte de ce revêtement.

2. Tube à rayons cathodiques selon la revendication 1, caractérisé en ce que l'épaisseur dudit revêtement est compris entre environ 0,075 mm et 0,125 mm.

3. Procédé de fabrication d'un tube à rayons cathodiques selon la revendication 1 qui consiste à appliquer une composition de revêtement sur une surface externe de verre de ladite enveloppe excluant ladite fenêtre et à chauffer ensuite le tube ainsi revêtu jusqu'à une température suffisante pour réaliser l'adhérence dudit revêtement sur ladite surface, caractérisé en ce que l'on effectue un préchauffage du tube entre 20°C et 90°C environ, on applique ladite composition de revêtement par enduction à la brosse, par écoulement ou par pulvérisation sur ladite surface de l'enveloppe d'une émulsion de polyuréthane à base d'eau et on chauffe ledit tube ainsi revêtu à une température de l'ordre de 20°C à 120°C pendant environ 30 à 5 minutes.

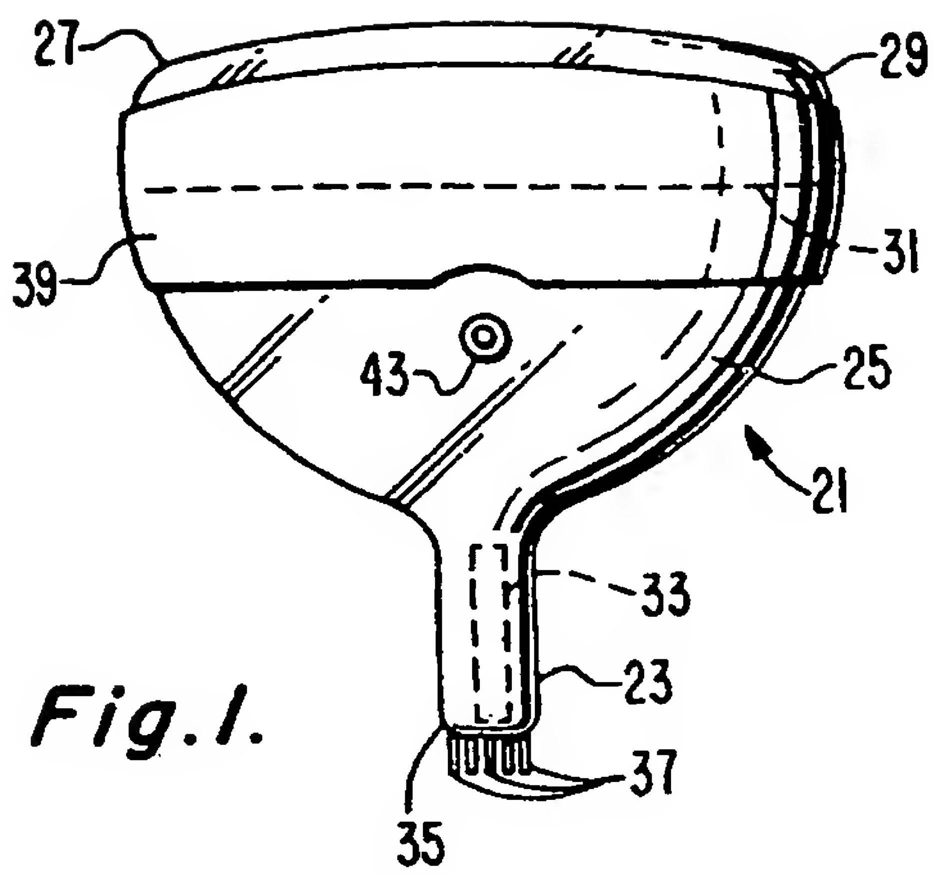


Fig.1.

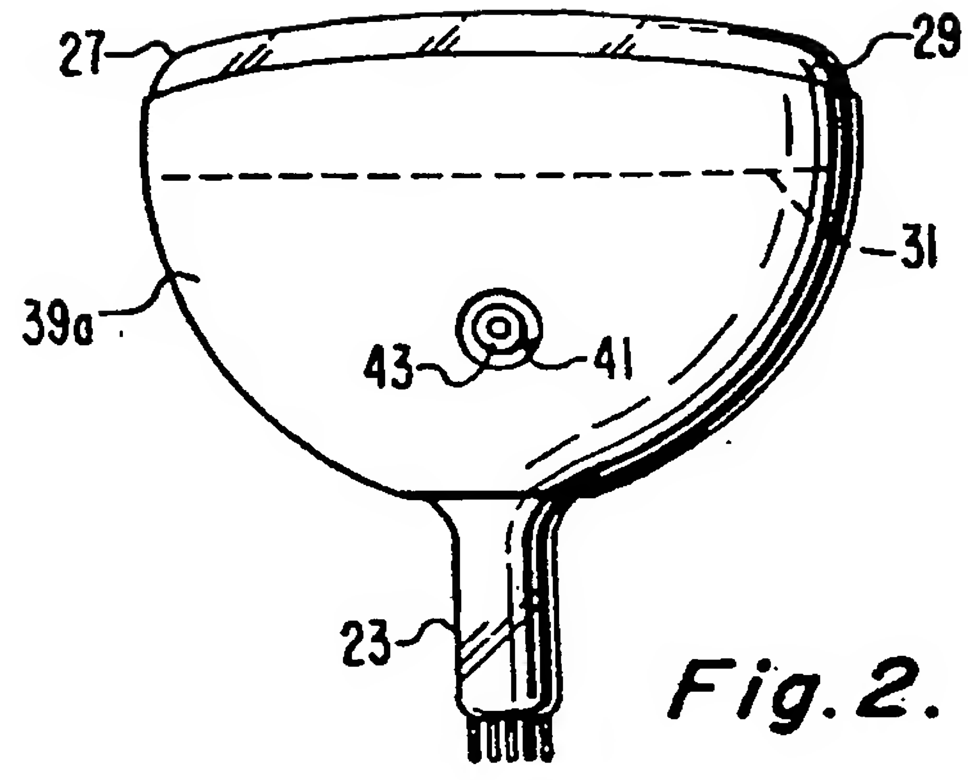
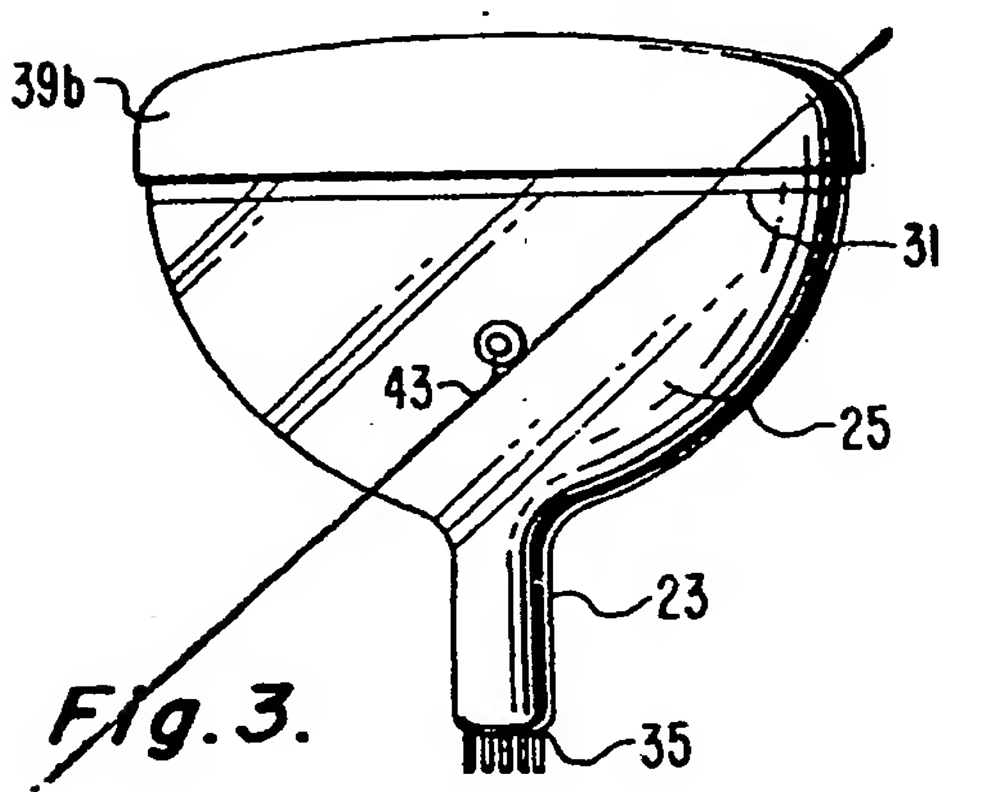


Fig.2.



~~Fig.3.~~

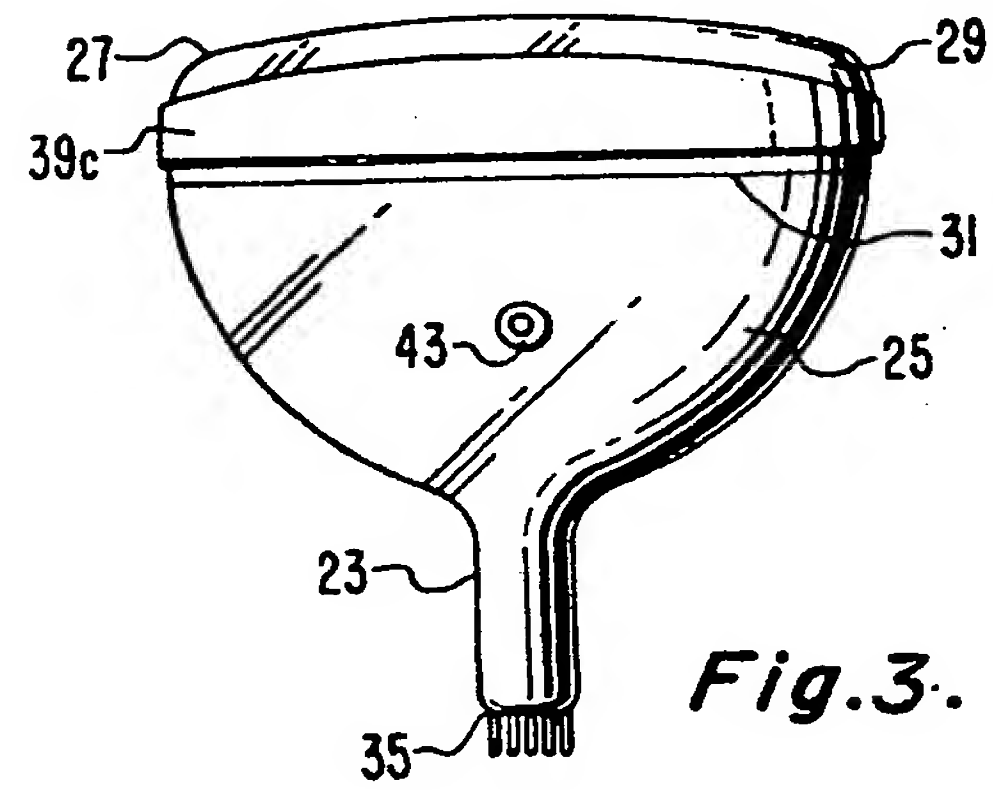


Fig.3.

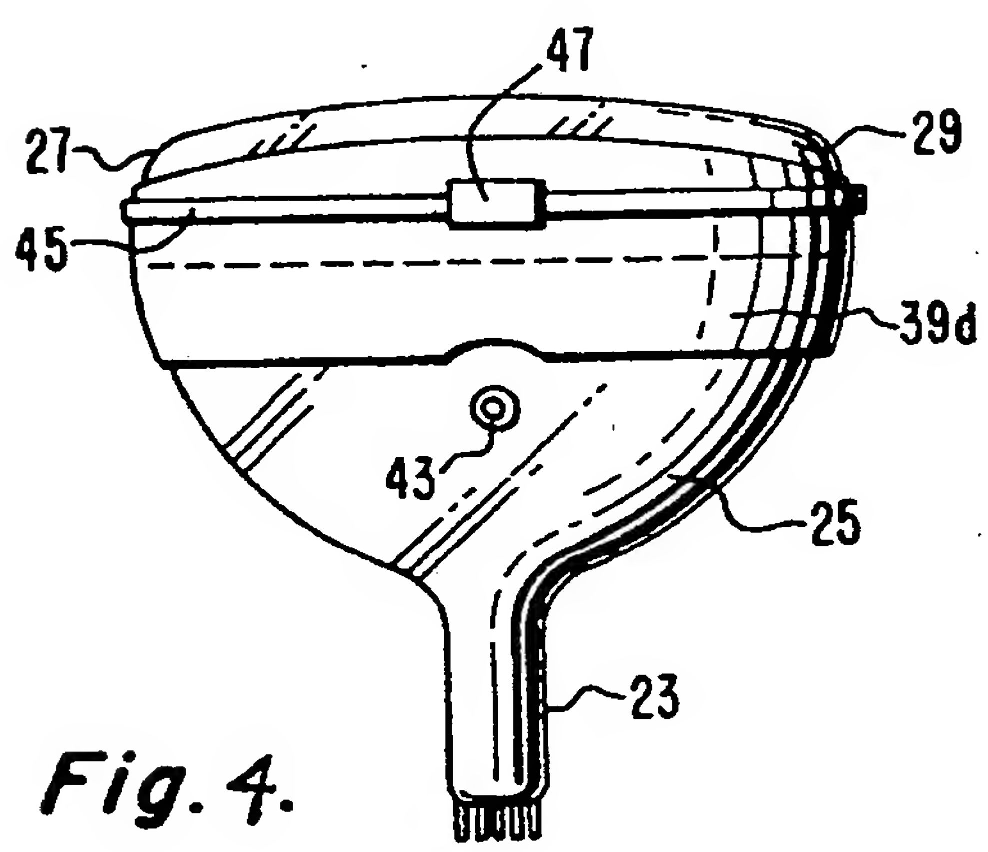


Fig.4.

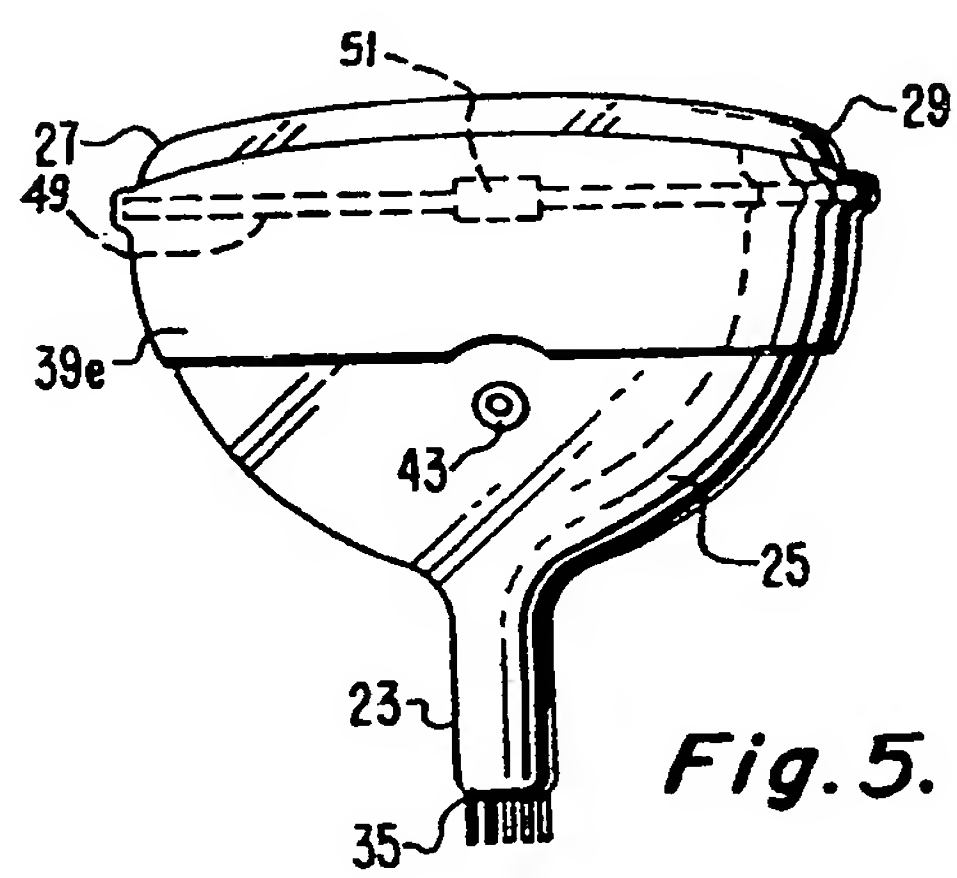
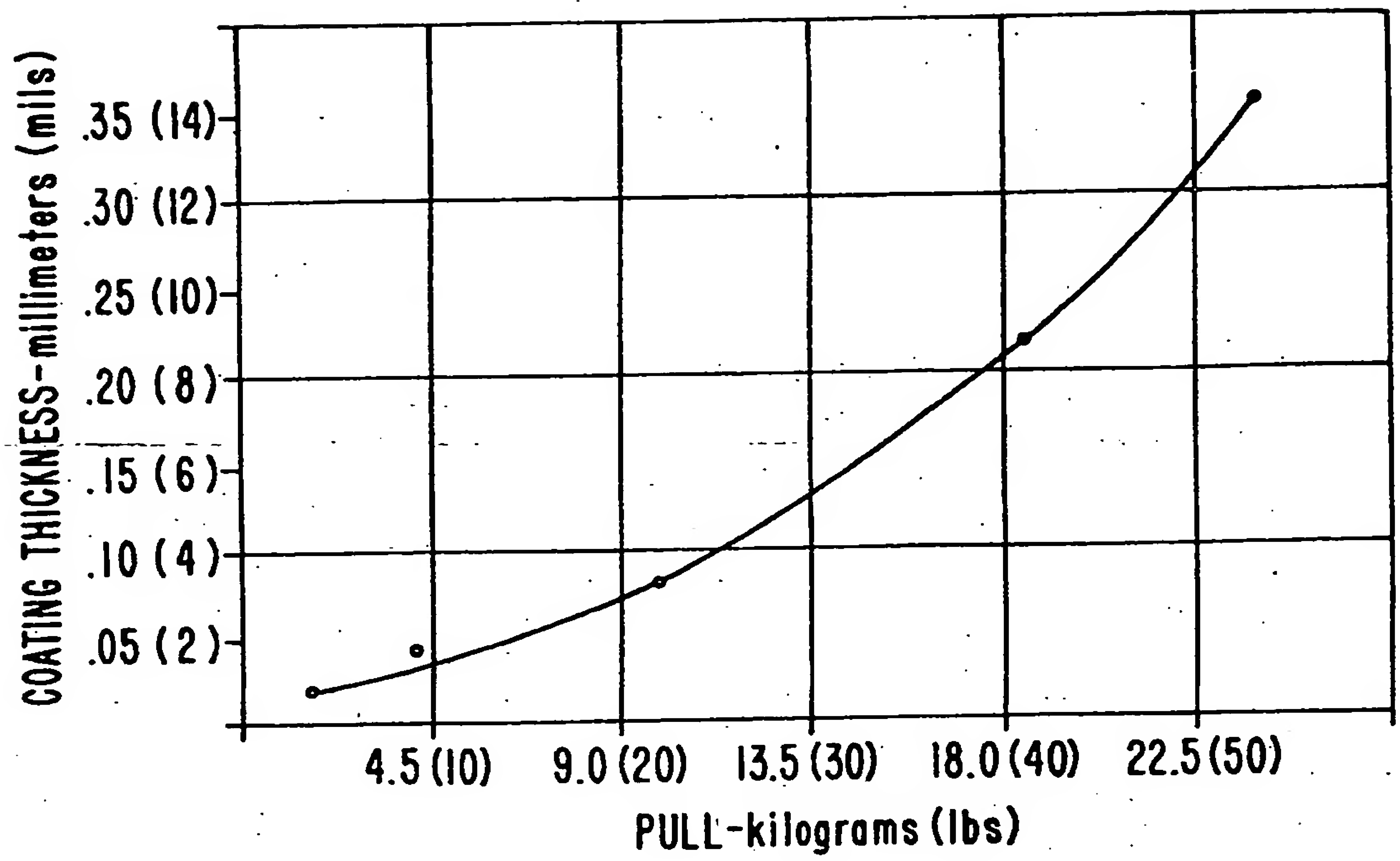


Fig.5.

Fig.6.



COATING THICKNESS-millimeters (mils)
.35 (14)
.30 (12)
.25 (10)
.20 (8)
.15 (6)
.10 (4)
.05 (2)
4.5 (10)
9.0 (20)
13.5 (30)
18.0 (40)
22.5 (50)
PULL-kilograms (lbs)